Preface

Epoxy resins are considered to be one of the most important classes of thermosetting polymers. They have been used extensively as high performance adhesive composite materials due to their outstanding mechanical and thermal properties such as high modulus and tensile strength, low creep, high glass transition temperature, high thermal stability, and good moisture resistance. In the cured state, epoxy resins are brittle materials with low impact strength and fracture toughness. In order to remain competitive as the materials of choice for many applications such as adhesives and composite matrices, epoxies should be modified to improve their fracture toughness. One of the successful methods used to toughen epoxy resins is the incorporation of the rubber phase into the brittle epoxy matrix, which may be achieved by the use of reactive liquid rubber or preformed rubber particles. The rubbers are initially miscible with the epoxy, but during the polymerisation, the rubber phase separates due to slight immiscibility with the matrix. At the proper concentration of rubber, the dispersed rubber phase can improve the toughness without a significant decrease in the other properties of the epoxies. The improvement in the toughness of rubber-toughened epoxies has been associated with the toughening mechanisms such as crazing, shear banding, and elastic deformation of the rubber particles.

The thesis presents an account of toughening of epoxy resin with liquid natural rubbers. Hydroxy and epoxy terminated liquid natural rubbers were synthesised and used for modification. The thesis includes ten chapters. An extensive report of epoxy resins, curing agents, curing mechanisms, additives and fillers is given in Chapter 1. It also highlights the different modifications usually employed for toughening, for example, elastomers,
thermoplastics, nanofillers etc. The toughening mechanisms include rubber particle cavitation, particle bridging, crack path deflection, and shear banding and local plastic deformation of the matrix through shear yielding. The scope and objectives of the present work are also discussed in this chapter. Chapter 2 deals with the experimental techniques used for the characterisation of the materials and blends used. In Chapter 3, the synthesis and characterisation of liquid natural rubbers are discussed in detail. The miscibility and morphological studies of epoxy rubber blends are described in Chapter 4. In Chapter 5, FTIR and DSC studies performed on the epoxy/rubber blends to monitor the cure reaction is detailed. The cure kinetics of epoxy resin modified with HTLNR cured with nadic methyl anhydride in presence of N, N - dimethyl aniline as catalyst is also investigated. Kamal's autocatalytic model was utilised to understand the kinetics of cure reaction. Dynamic mechanical analysis of epoxy/HTLNR and epoxy/ETLNR blends have been dealt with in Chapter 6. The effect of decrease in molecular weight of the modifier on the viscoelastic behaviour of epoxy/ETLNR blends was studied using low molecular weight ETLNR(L). Chapter 7 deals with the rheological analysis of epoxy/HTLNR and epoxy/ETLNR blends. The mechanical properties of epoxy/rubber blends were discussed in Chapter 8. An attempt was made to study the localised mechanical properties through Nanoindentation. The properties and thermal stability of epoxy resin were not affected by the addition of liquid rubbers as discussed in Chapter 9. The overall conclusion of the present study, applications and future scope are discussed in Chapter 10.